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ABSTRACT

The theoretical basis of programmed instruction and the sequential skill development approach used at University of Louisville's University College are described, and results of student testing to determine the effectiveness of programmed instruction in the school's remedial program are examined. Nine areas of basic competencies needed for college that relate to cognitive, affective, mechanical, and psychophysical skills are identified. The remedial courses are programmed in small steps, and individualized instruction is used to promote sequential skill development. Nine hierarchies of competence in higher order cognitive processes that have been proposed by investigators are presented, and theoretical issues are analyzed. The Watson-Glaser Critical Thinking Appraisal was administered to students enrolled in remedial courses and students enrolled in a general education course (social sciences and humanities) to determine the effects of programmed instruction provided in the remedial program. The general education course did not provide the incremental drills characteristic of programmed learning. Students in both groups had similar characteristics. Pretesting and posttesting with the Watson-Glaser test indicated that students enrolled in the listening and comprehension and the critical thinking remedial courses increased their mean scores more significantly than did other students. This finding is attributed to the instructional formats of these courses. References are included. (SW)

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THE ROLE OF PROGRAMMED INSTRUCTION FOR SEQUENTIAL SKILL DEVELOPMENT IN HIGHER EDUCATION

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HE 013 446

The Role of Programmed Instruction for Sequential Skill Development in Higher Education

Competent, responsible management of society in the future requires a college-educated citizenry. Such a claim is not elitist; rather it reflects the traditional and contemporary value placed on higher education. In an egalitarian society, higher education can be made available to whoever aspires to it. However, which skills are prerequisite for entry into college, and which skills are to be developed within college have not been adequately studied in our society, for the language of education has only begun to speak of measurable competencies. Determining the nature of these skills will allow the design of educational programs in both secondary and post-secondary education which form a continuum of skill development. The competent citizen must, beginning his education in childhood, sequentially develop skills which lead to the mature cognitive, affective, interpersonal, social, and psychophysical performances required of him as an adult.[1]

The recognition that education, even at the college and graduate levels, is the development of skills which enable one to acquire, produce, and utilize knowledge, is the first step towards a competent society. Recently, higher educators have recognized this and have sought to encourage new developments in college curricula which will respond to this challenge. The Carnegie Foundation for the Advancement of Teaching, in discussing the importance of a broad exposure to the liberal arts, names three essential characteristics of a sound undergraduate education (Carnegie Foundation for the Advancement of Teaching, 1977, 165):

1. Builds skills for advanced studies and lifelong learning.
2. Distributes time available for learning in such a way as to expose students to the mainstreams of thought and interpretation--humanities, science, social science, and the arts.
3. Integrates learning in ways that cultivate the student's broad understanding and ability to think about a large and complex subject.

A. Sequential Skill Development at University College, University of Louisville

The majority of students enrolled at University College of the University of Louisville are "open admissions" students who have composite scores below 18 on the American College Testing Program (ACT) examination. We have established a Developmental Education Center at University College which does research into the higher cognitive and affective skills necessary for suc essful achievement in college and develops competency-oriented curricula in introductory and advanced courses in the humanities, social sciences, and natural sciences, so that the skills we identify can be explicitly taught and asscssed. Our effort extends to identifying the skills prerequisite to adequate college performance; thus, we offer a remedial program of higher cognitive, affective, mechanical, and psycho-physical skill development.

We have identified nine areas of basic competencies that underlie college level performance. These are 1) self-concept and motivation; 2) reading; 3) quantitative skills; 4) oral communication and group behavior; 5) written communication; 6) basic information (political, demographic; geographic; and, historical facts); 7) mechanical skills (using audio-visual aids, typing, using computer terminals, etc.); 8) critical thinking skills; and 9) research skills.

These remedial areas can be seen as part of a continuum of skills and information which have their higher order equivalents at the general-education level. (See Appendix A.)

Our courses are competency-oriented at both the remedial and general education level. The general education courses stress the skills of academic inquiry within the social sciences, humanities, and natural sciences, skills generic[2] to the disciplines within each major division; for example, in the social sciences we stress the formulation of researchable questions, concept development, data gathering methods, and data analysis. The junior-senior courses offered at University College form part of a bachelor degree program in liberal studies, an interdisciplinary degree whose foundation is the "generic"

skill general-education courses. We are continually seeking to define the more complex skills that are integral to this higher level study. Viewing higher order cognitive psychophysical, affective, interpersonal, and social processes as points on a continuum of skill development helps us to identify the skill clusters that make up the independent thought and research which are integral to the junior-senior levels. (See Appendix B.)

B. Individualized Instruction and Sequential Skill Development

To learn skills in sequence, one set of operations must be mastered before another set can be learned in the skill continuum. We are interested in validating (as well as benefiting) from the research of those educators who have identified such "hierarchies of competence"[3] in higher order cognitive processes. Table I shows six classes of these processes; classes I-IV may be viewed developmentally as a movement from basic to more complex skills accomplished in childhood and adolescence.[4] Classes V and VI are operations which are brought to the synthetic products of Class IV.

The most effective means of instruction for developing a competence is one that provides explicit opportunities for its exercise, and a means of assessing its mastery performance. Individualized instruction is one methodology which has been used effectively in the development of human skills in this sequential, incremental manner.

Individualized instruction is a learning experience designed for the individual rather than the group. It presents its content through formats that permit the individual to manage the material selected for study, and to exercise a particular skill at the pace which most suits his competence level. Effective individualized instructional materials guide a student's progress from one phase of learning to another, signaling him when he has mastered a concept or skill. Thus, individualized instruction permits the student to control his learning experiences, and a logic that steers and reinforces successful learning.

The notion of incremental steps, which lead the student sequentially from

(Thomas, 1972)

TABLE I

(Thomas, 1972)

Taxonomies of the Cognitive Domain

I. Cognitive Processes — General

CLASSES OF HIGHER ORDER COGNITIVE PROCESSES	Berman, L.M., 1967 (Cognitive Processes)	Bloom, B.S., et al., 1956 (Cognitive Objectives)	Burns, R.W. and G.D. Brooks, 1970 (Cognitive Processes)	Cole, H.P., 1960 (Intellectual Processes)	Gerhard, M., 1971 (Cognitive Strategies)	Guilford, J.P., 1967 (Cognitive Abilities)	Hills, J.L., 1969 (Cognitive Processes)	Raths, L.E. et al., 1967 (Thinking Operations)	Williams, F.E. National Schools Project, 1970 (Primary Mental Abilities)
I LEARNING TO LEARN PROCESSES	Organizing	Comprehension Knowledge		Attending and Orienting Listening Direction Following Observation Skills		Memory Cognition	Attending		Cognitive Ability Awareness Comprehension Memory Storage Retention
II COMMUNICATION PROCESSES	Summarizing	Application	Abstracting	Translation and Transformation Figural Decoding			Observing	Observing Summarizing	
III CLASSIFYING AND COMPARING PROCESSES	Classifying Defining Comparing Analyzing	Analysis	Classifying Sequencing Equating Analyzing	Classification Perceptual and Cognitive Discrimination Attribute Identification Serial Ordering Iteration Measurement	Classifying/Categorizing Concept Formation Comparing Analysis Convergent Thinking	Convergent Thinking	Classifying Comparing Contrasting	Classifying Comparing Interpreting	Convergent Thinking Redefinition Transformations Best Solution Improvisations
IV SYNTHESIZING AND PRODUCING PROCESSES	Fluency Flexibility Originality Ability to Elaborate Predicting Consequences Seeing Causes Synthesizing Generalizing Sensitivity to Problems	Synthesis	Synthesizing Generalizing Simulating Theorizing Translating	Flexibility and Divergence Diver. Interpretation Diver. Production Fluency Elaboration Decentration Inquiry Problem Solving	Associating Inductive Reasoning Reasoning Synthesis Creative Thinking Divergent Thinking	Divergent Thinking	Predicting	Imagining Hypothesizing Applying Facts and Principles in New Situations Designing Projects or Investigations	Divergent Thinking Fluency Flexibility Originality Elaboration
V JUDGING AND EVALUATING PROCESSES	Criticizing Interpreting Data Asking Useful Questions	Evaluation	Evaluating Inferring		Deductive Reasoning Critical Thinking	Evaluation	Making Inferences Generalizations Operational Defining Testing a Hypothesis Formulation of a Model	Coding Criticizing Looking for Assumptions Collecting and Organizing Data	Evaluative Ability
VI VALUE ANALYSIS AND DECISION MAKING PROCESSES							Valuing Decision Making Policy Making Conceptualization of Values	Decision Making	

one learning task to the next, is often called programmed learning. Not all individualized instruction works with incremental steps, however. Jerome Bruner writes of programmed instruction (Briggs, 1978, 21-22).

> There is in the current doctrine (I will call it) of programmed instruction, the idea that somehow you should take small steps, that each increment should be a small step. Now, this idea is derived willy-nilly from a theory of learning which states that learning is incremental and goes in small steps. Nowhere in the evidence upon which such a theory is based--and it is only partial evidence--nowhere is there anything that says that simply because learning takes place in small steps, the environment should be arranged in small steps. In doing so, we fail to take sight of the fact that, indeed, organisms from vertebrate on up through the highest primate, man, operate by taking large packets of information and breaking these down into their own bite size and that unless they have the opportunity to do that, learning may become stereotyped...

Thus, Bruner shies away from tight programmed sequences in his approach, although, for him, individualization is critical in education. Bruner lists four key features of any instructional theory, all of which reinforce individualization (Bruner, 1968, 40-41):

1. A theory of instruction should specify the experiences which most effectively implant in the individual a predisposition toward learning.

2. A theory of instruction must specify the ways in which a body of knowledge should be structured so that it can be most readily grasped by the learner.

3. A theory of instruction should specify the most effective sequences in which to present the material to be learned.

4. A theory of instruction should specify the nature and pacing of rewards and punishments in the process of learning and teaching.

Bruner goes on to specify six ways to individualize curricula effectively (Briggs, 1968, 22): "a) arrange it that the student grasps the structure by induction from particular instances; b) give practice in transfer when transfer is expected as a result of learning; c) use contrast in the sequence; d) avoid premature symbolization; provide for images first; e) give practice in both leaping and plodding; small steps are sometimes necessary, but without great leaps involving guessing a (student) is deprived of his rights as a mind; f) provide for revisiting--through use of spiral programs so as to not expect that the full value of a matter being studied is grasped always in a single block like a linear sequence." These six instructional design principles are

integrated into our general education level courses which introduce academic inquiry in the sciences and humanities. Some of them, such as spiral development in skill learning, and the use of concrete instances to enhance induction, are also used in the remedial, programmed courses. The general education level courses, however, are closest to the non-programmed guidelines of Bruner. The major exception to Bruner's position we take in the general education level courses is our use of structured worksheets which guide the student even during independent field research.

Robert Gagné, another prominent educator involved with individualized education, differs from Bruner in that he supports the identification of small sequential phases that methodically lead the student to mastery of a clearly defined skill. Gagné places strong emphasis on the hierarchies of competence in higher cognitive skills (as well as in other human ability areas) which can be shaped through the instructional sequences that are permitted by programmed, individualized learning. (Briggs, 1968, 20-21.)

Bruner's allowance for leaps of inference and original creative work on a problem, within individualized instruction, is important to academic inquiry, but, without Gagné's stress on hierarchies of competence, no adequate basis in lower-level skills for such higher-level performance would exist. Thus, in our general-education level, project-oriented courses incorporate Bruner's principles of individualization, allowing the student to formulate a personally meaningful research question, and to conduct his own inquiry to develop an answer. However, a student cannot effectively pursue such independent work without a thorough mastery of the lower-level skills in this "hierarchy of competence." Our remedial courses, which are programmed in small steps, make the general education level "great leap" courses possible.

The value of programmed instruction lies not only in the care one may exercise in the incremental development of a specified skill, but also in certain cognitive and affective skills which are the outcome of such focused learning. Programmed instruction develops not only the skills which are the

subject matter of the instructional unit, but also the process skills which are imparted by the characteristic method of this instruction. These are the "learning to learn" processes (Thomas, 1973) and the basic critical thinking operations (Thomas, 1973) which are prerequisite for more complex skill learning, fundamental skills lacking in many of the students who attempt higher level courses. By offering remedial courses in essential academic areas (e.g., vocabulary, spelling, standard English usage, etc.) and delivering this instruction via a mode of study that also produces the "process" skill development, we achieve a rapid increase in the student's capacity to meet the demands of general-education level skill proficiency.

Several "learning to learn" processes and low-level critical thinking skills acquired through exposure to programmed instruction have been identified in past decades of educational research. A summary of the effects claimed include:

1. Self-reliance and personal management of the learning process: (Garner, 1966; Russell, 1974)

The student acquires confidence in his ability to choose instructional materials and methods without the stimulus of an instructor. He acquires this ability as the result of self-directed progress with programmed materials designed so that he can identify the learning sequences necessary for mastery of a content or skill area, locate the necessary units and materials, and evaluate his own progress.

2. Anxiety control in the learning process: (W. J. Carr, 1959; Lieberman, Yalom, and Miles, 1973)

The student learns to govern anxiety as the result of his own control over the amount of work done, the time in which it is completed, and the clear and reliable reinforcement for work accomplished. The objective criteria for successful achievement, as well as for work that must be corrected, allows the student to accomplish and value his activity without filtering his effort through the subjective presence of the teacher.

3. Facility in following complex routines and procedures: (Garner, 1966; Briggs, 1960; Russell, 1974; Fowler, 1967)

Practice in following the detailed, thorough procedures necessary for an effective, programmed instructional unit, develops in the student the ability to mentally and psychophysically interpret such logical maps in any context.

4. Positive attitude developed toward learning:
(Garner, 1966, Russell, 1974)

The immediate, certain reinforcement received in learning through programmed units stimulates the production of a positive attitude toward the content learned, an attitude that carries over to any learning achieved through the same or similar instructional system.

5. Recognition of a personal learning style:
(Garner, 1966; W. J. Carr, 1959; Russell, 1974)

The self-management involved in learning with programmed materials enables the student to become familiar with personal preferences in the time given to study, and in the division of time allotted to problem-solving, reflection, evaluation, and correction of one's own work.

6. Ability to attend to specific detail and discern differences:
(Briggs, 1968; Russell, 1974; Fowler, 1967; Gagné, 1968)

The close reading entailed in following the directions and subject matter in a programmed unit provides constant practice in discrimination. The intensive attention to detail cultivated by a carefully programmed unit cannot be duplicated in a solely teacher-directed course.

7. Concentration and awareness in task performance:
(Briggs, 1968; Smith and Moore, 1965; Gagné, 1974; Russell, 1974)

The clarity of objectives, questions, and response procedures in the programmed unit develops an "attentional set" in students which enables them to sustain concentration over increasingly long periods of time.

8. Simple critical thinking discriminations, i.e., distinguishing fact from opinion, making inferences from facts, sorting and classifying, etc.
(Garner, 1966; Briggs, 1968; Fowler, 1967; Gagné, 1974; Thomas, 1972)

The coherent, logically sequenced questions which lead students step-by-step through a programmed unit, lend to the development of critical thinking competencies which enable simple discrimination and inference.

The promise of development in these process skills led, in part, to our use of commerical and original programmed instructional units to teach remedial academic skills to students. In order to determine whether these eight process skill areas are part of student skill growth, a program of pre- and post-testing has begun that attempts to measure entry and exit levels of these process skills as students engage in the programmed instruction. The claims made by proponents of programmed instruction must be tested with appropriate measures. We are gradually locating instruments with which to evaluate these possible benefits.

C. Testing to Determine the Effects of Programmed Instruction

To test the effects of programmed instruction on students enrolled in our remedial program in the Fall, 1978, we identified measures which would test the claims of hypotheses six through eight (above). Our experimental group consisted of students enrolled in the remedial courses. Our control group was selected from students enrolled in a concurrent general-education level course introducing the social sciences and humanities. Students in both groups had similar characteristics.

The remedial courses are individualized in the manner suggested by Gagné: their content consists of sequential skills which are developed in a programmed manner; the student is guided step-by-step through drill activities towards mastery in each skill at a certain level of performance. The general education level course in inquiry is somewhat individualized, incorporating the principles of Bruner. It is a project-oriented course that engages the student in actual research. While it has worksheets to guide student work in phases of academic inquiry, the incremental drills characteristic of programmed learning are absent. The remedial courses in the Fall, 1978 were:

DEC 060 SPELLING 3 credits. An individualized, self-instructional course in standard American-English spelling.

DEC 063 VOCABULARY DEVELOPMENT 3 credits. An individualized course designed to help the student expand his understanding and use of spoken and written English.

DEC 065 STANDARD USAGE 3 credits. An individualized, self-instruction course in the standard use of common American-English patterns (e.g., noun plurals, possessives, verb tenses and forms, pronouns, adjectives, adverbs, etc.)

DEC 070 LISTENING AND CONCENTRATION 3 credits. A self-instructional, individualized course in improving listening comprehension and concentration.

DEC 080 CRITICAL THINKING 3 credits. An individualized course which helps the student to separate facts from opinions, draw inferences, accurately report phenomena, and make judgments based on logical criteria.

Evaluation of content mastery within each course is determined by successful completion and correction of the exercises which build information and skills incrementally, and by periodic mastery examinations.

The "learning to learn" processes and low level critical thinking skills claimed as outcomes of programmed instruction (hypotheses six through eight) were evaluated by pre- and post-testing students in both the treatment and control groups with the Watson-Glaser Critical Thinking Appraisal. These low-level critical thinking skills and "learning to learn" processes are discussed in the literature of critical thinking (Thomas and Taylor, 1975; Thomas, 1973), The Watson-Glaser Critical Thinking Appraisal is composed of five tests, designated as Inference, Recognition of Assumptions, Deduction, Interpretation, and Evaluation of Arguments. Distinguishing fact from opinion, and inferring from fact and opinion underlie each of these five divisions, thus can be seen as the lower level skills we wish to measure.

The control group, drawn from the course introducing the social sciences and humanities, was exposed to an instructional design which assumed previous mastery of these lower level skills. The course required students to complete an individual research project in both the social sciences and humanities. The more complex critical thinking skills required in this course included the synthetic (or knowledge production) skills (Blum and Spangehl, 1978) of formulating researchable questions, developing adequate and logical research designs, gathering data with appropriate research methods, and evaluating the data in light of the questions to be answered. None of the students in the control group had been exposed to the remedial courses before this semester or during the semester. (Thus, we could not assume they had mastered the necessary lower level skills.)

D. The Results of the Study

In the following tables we show the results of the pre- and post-testing given the treatment and control group with the Watson-Glaser Critical Thinking Appraisal.

TABLE 11

Form YM of the Watson-Glaser was used as a pre-test and Form ZM as a post-test. The ZM scores were converted to YM scores according to the instruction manual for the test, and the change in Watson-Glaser score over the semester was calculated for each student. These changes are as follows:

MEAN CHANGE IN WATSON-GLASER CRITICAL THINKING APPRAISAL SCORES FOR SELECTED POPULATIONS, FALL SEMESTER 1978 - 1979

GROUP	N	MEAN CHANGE	STANDARD DEVIATION
All students*	94	0.766	7.891
DEC 060 Treatment**	3	4.333	7.552
DEC 063 Treatment**	17	2.794	7.155
DEC 065 Treatment**	5	4.100	8.340
DEC 070 Treatment**	10	8.600	5.675
DEC 080 Treatment**	11	7.727	5.502
LBST 101 Treatment**	63	-1.405	7.746

*This group includes all those who took the Watson-Glaser Critical Thinking Appraisal at the beginning and end of the Fall 1978 - 1979 Semester and registered for any of the following courses: DEC 060, DEC 063, DEC 065, DEC 070, DEC 080, LBST 101, and LBST 103.

**These groups include only those who took the Watson-Glaser Critical Thinking Appraisal at the beginning and end of the Fall 1978 - 1979 Semester and were exposed to treatment in the courses specified. Exposure to treatment was defined as receipt of the following course grades: A, B, C, or I; non-treatment was defined as receipt of the following course grades: F, W, NR.

ANALYSIS OF VARIANCE (T-Test):

Analysis of variance for students taking DEC 070 and DEC 080 indicates that the differences in mean increase on the Watson-Glaser Critical Thinking Appraisal are significant:

GROUPS	n	MEAN INCREASE	SD	df	t
Students treated in DEC 070	10	8.6000	5.675	92	3.52*
Students not treated in DEC 070	84	-0.1667	7.616		
Students treated in DEC 080	11	7.7273	5.502	92	3.27**
Students not treated in DEC 080	83	-0.1566	7.718		

*significant at the $p < .001$ level
**significant at the $p < .005$ level

In addition, analysis reveals that the difference in mean increases for students taking lab courses versus students taking non-laboratory courses is also significant:

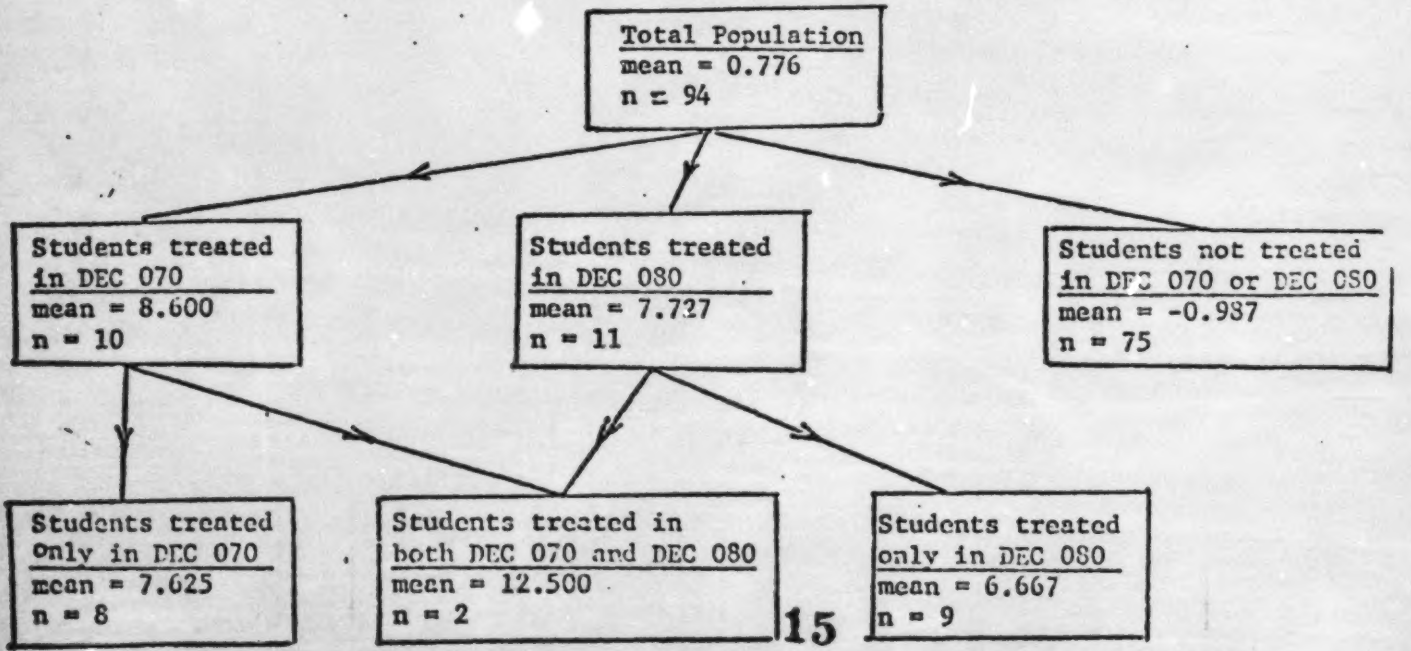
GROUPS	n	MEAN INCREASE	SD	df	t
Students treated in LBST 101 who were not concurrently enrolled in any DEC lab course	63	-1.4048	7.746	91	-4.05*
Students treated in lab courses who were not concurrently enrolled in LBST 101	30	5.1833	6.352		

*significant at the $p < .001$ level

TABLE IV

The chart below makes these changes clearer and displays the inter-relationship between DEC 070 and DEC 080.

CHANGE IN WATSON-GLASER CRITICAL THINKING APPRAISAL SCORE
BROKEN DOWN BY TREATMENTS RECEIVED, FALL SEMESTER 1978 - 1979


Total Population
mean = 0.776
n = 94
Students treated in DEC 070
mean = 8.600
n = 10
Students treated in DEC 080
mean = 7.727
n = 11
Students not treated in DEC 070 or DEC 080
mean = -0.987
n = 75
Students treated only in DEC 070
mean = 7.625
n = 8
Students treated in both DEC 070 and DEC 080
mean = 12.500
n = 2
Students treated only in DEC 080
mean = 6.667
n = 9

E. Discussion

The most significant increases in mean score were for those students taking DEC 070 (+8.6) and for students taking DEC 080 (+7.727).

Interesting, though statistically insignificant, were two students who took both DEC 070 and DEC 080 and who showed a mean increase of +12.5. This may indicate a combination of treatments is educationally superior to separate courses, although more study is necessary.

The increase in DEC 080 is to be expected. The course specifically deals with the skills tested by the Watson-Glaser. The instructional format of this course consists of structured lessons which drill the student in specific critical thinking competencies, such as distinguishing fact from opinion, making inferences from verbal and visual facts, interpreting reports, sorting and classifying information, making comparisons, constructing analogies, etc.. The course materials in their content and graphic design set clear objectives, provide guidance in giving specific answers, and emphasize repetition and reinforcement, exhibiting generally the characteristics of instructional format that are said to produce the results claimed in propositions six through eight.

The increase in DEC 070 was less expected.[5] The content of the course is listening skill, not critical thinking. However, the instructional format has the above characteristics of clarity in objectives, repetition, and reinforcement, etc., of standard, well-designed programmed materials. The course content is designed to train students in short and long term memory and to increase the student's ability to concentrate on and retain information presented orally. There is no specific skill taught that is tested on the Watson-Glaser Critical Thinking Appraisal. Therefore, we can infer that the substantial increase can better be explained by the instructional format than the course's content. The skills described in hypotheses six and seven seem to contribute strongly to success on the Watson-Glaser.

The competency of "attention" which enables a student to comprehend clearly stated objectives and to make accurate responses, is explicitly part of the DEC 070 course content; it trains the student to focus attention, to respond as accurately as possible to a question. Attention to specific detail, and the discernment of difference is also a major emphasis. Thus, although the low level critical thinking skills were not taught (those skills asserted as outcomes of programmed materials in hypothesis eight), performance in questions that drew upon such skill competency was high. We infer that "attentional set" may have more to do with success in such low-level critical thinking than even specific training in the skill operations themselves.

There was a small but respectable increase in the Watson-Glaser scores of students who were enrolled in the other DEC courses, although the content of these courses bore no relation to the skills of critical thinking included in hypothesis eight, or tested explicitly by the Watson-Glaser. In these courses, the instructional format was individualized and programmed. The effects must be seen as resulting from the skills claimed in hypothesis six, those that lend to attention of specific detail and the discernment of differences, and, to a lesser extent, the skills claimed in hypothesis seven, the ability to attend to and perform specific objectives.

The lack of significant gain in the LBST 101 course is not puzzling when one considers the structure of the course and the fact that students who take the course have not yet been carefully screened for prerequisite skills. While the LBST 101 course does rely on structured worksheets which can provide the type of detailed, adherence to clear objectives demanded by programmed materials, the course as a whole allows much more self-initiated inquiry. In order to complete the social science and humanities projects, complex skills such as planning and carrying out research designs and compiling and reporting results are required. The Watson Glaser tests lower level

skills, which should be used in the process of the LBST 101 course when gathering facts, inferring from facts, and evaluating results, but the students are not explicitly trained in these specific skills in the course, nor does the course have enough of the repetition and reinforcement offered by programmed materials to develop these skills through instructional format. Thus, hypotheses six through eight will hold for individualized, programmed instructional formats, but not for a more open, inquiry course.

We plan to augment the LBST 101 next semester with more programmed, repetition and reinforcement activities in order to achieve the gains in lower-level critical thinking which appear to be the effects of such an instructional format. We can incorporate this approach at the points where students begin to plan their research design, where they compile results, and where they prepare to infer from the facts they have gathered.

APPENDIX A

OBJECTIVES FOR DEVELOPMENT AND OPERATION OF COURSE, 1979-1982

D=DEVELOPMENT
O=OPERATION

COURSES		1979-80	1980-81	1981-82
DEC 001	Orientation	O	O	O
DEC 050	Presentation Skills		D	O
*DEC 059	Listening and Concentration	O	O	O
*DEC 060	Spelling I	O	O	O
*DEC 061	Spelling II	O	O	O
*DEC 065	Standard Usage	O	O	O
DEC 068	The Mechanics of Writing	D	O	O
DEC 069	Basic Organization in Writing		D	O
*DEC 073	Vocabulary Development I	O	O	O
*DEC 074	Vocabulary Development II	O	O	O
DEC 075	Basic Facts in World Events	D	O	O
*DEC 080	Critical Thinking I	O	O	O
DEC 081	Critical Thinking II	D	O	O
DEC 090	Research Skills: Taking Notes		D	O
DEC 091	Research Skills: Questions			D

*Denotes courses developed and in operation before 1979-80 academic year

OBJECTIVES FOR DEVELOPMENT AND OPERATION OF COURSES, 1979-1982

D=DEVELOPMENT
O=OPERATION

COURSES		1979-80	1980-81	1981-82
LBST 101	Ideas & Research: Creative Expression	D	O	O
*LBST 102	Ideas & Research: Behavioral Studies	O	O	O
LBST 103	Ideas & Research: Scientific Studies	D	O	O
*LBST 104	Case Studies in Creative Expression	O	O	O
*LBST 105	Case Studies in Behavior and Institutions	O	O	O
LBST 106	Case Studies in Science and Technology		D	O
*LBST 110	Academic Library Research	O	O	O
LBST 201	Guided Reading, Reporting: Creative Expression		D	O
LBST 202	Guided Reading, Reporting: Behavioral Studies		D	O
LBST 203	Guided Reading, Reporting: Scientific Studies		D	O
LBST 250	Independent Reading in Interdisciplinary Areas			D
LBST 299	Independent Projects in Interdisciplinary Areas			D

*Denotes courses developed and in operation before 1979-80 academic year

APPENDIX B

Population Studied

The population studied included 242 students--all those taking courses under the direct control of the Developmental Education Center during the Fall Semester of 1978 - 1979. Of this group, 139 (or 57.4%) were males, and 103 (or 42.6%) were females. Of the 166 students for whom we had full information, the average age was 20.6 years; the standard deviation was 5.86 years, making this a varied age group. (Year of birth varied from 1905 to 1961.) For those on whom standardized national test scores were available, the means were far below national norms; there is no reason to suppose that those for whom test scores were not available would, if tested, increase the means in the table below:

SELECTED CHARACTERISTICS
OF POPULATION STUDIED

MEASURE	MEAN	MEDIAN	SD	MIN	MAX	N
ACT Verbal Section	10.255	9.813	4.175	1.0	23.0	98
ACT Math Section	8.673	8.500	4.771	1.0	33.0	98
ACT Social Science Reading	9.133	8.033	4.264	2.0	25.0	98
ACT Natural Science Reading	13.276	13.167	4.814	2.0	30.0	98
ACT Composite Score	10.495	10.150	3.819	4.0	30.0	98
SAT Verbal Section	285.56	296.25	56.59	220	410	9
SAT Quantitative Section	301.11	280.00	66.79	230	410	9

Footnotes

[1]The developmental perspective which guides the research and teaching reported in this paper adheres to the ideas of cognitive and affective skill development discussed by Jean Piaget, Robert Gagné, and others who have researched the developmental stages of competency in the light of human maturation. For a more thorough discussion of skill development within higher education, see Blum and Spangehl, "Developmental Education and the University College: A Competency-Based Approach to Education," Resources in Education, Washington, D.C.: Health, Education, and Welfare, National Institute of Education, December, 1978 (ED 157813).

[2]Generic skills are those which are used throughout a discipline or division of knowledge, as opposed to specialized procedures which are developed to aid a particular experiment. A generic skill is a procedure, to be sure, but one that is transferable to any problem within a field if its data gathering methods are appropriate for the problem. See Blum and Spangehl (December, 1978) for a discussion of procedures and skills; see Gary Woditsch, Developing Generic Skills: A Model for Competency-Based General Education, CUE Project, Occasional Paper Series No. 3, Bowling Green, Ohio: Bowling Green State University, May, 1977, for a presentation of the concept of "generic skills."

[3]The idea of "hierarchies of competence" has been explored in the research of Robert M. Gagné over the past two decades. A partial bibliography of his writings appears in this paper. Leslie J. Briggs writes an informative overview of the instructional implications of Gagné's works in his book identified in the bibliography. John W. Thomas' creative work in programmed instruction at Research for Better Schools, Inc., a federally funded research and development laboratory that develops curricula in elementary and secondary education, follows closely the work of Gagné. His taxonomies of sequential higher cognitive skill development appears in Varieties of Cognitive Skills: Taxonomies and Models of the Intellect; other works by him are also listed in the bibliography of this paper.

[4]Thomas warns that such a presumption is not yet validated, and can only be posited for the type of study which might bring validation. He writes: "The ideal result of this analysis would be a continuum of cognitive skills. That is, instead of three taxonomies (classifications), the taxonomies would be integrated such that hierarchies would emerge within and across specific skill clusters. Instruction in memory skills would proceed from simple prerequisite skills to complex, more differentiated skills. Skills taught in isolation in early grades, e.g., listening skills, would be taught in conjunction with other skill areas in the later grades, e.g., listening skills with critical thinking skills. Again, this kind of organization could be imposed upon the analysis only with great risk to its validity." (Thomas, 1973, 22-23).

[5]Thomas (1973, 22-23) does claim that a combination of listening skills and critical thinking skills may be effective in promoting critical thinking development. His suggestion is made in the light of hierarchies of

competence, listening skills being a prerequisite for the facility in critical thinking. He does not say why this combination might be effective; our analysis is that concentration developed in listening may be a "learning to learn" process necessary for the focused thinking of critical thinking.

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